Research Note 84-141

THE FIRE SUPPORT TEAM VEHICLE (FIST-V) SYSTEM: AN ANALYSIS OF HUMAN FACTORS, TRAINING, SAFETY AND RELATED CONSIDERATIONS

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A human factors, training and safety evaluation of the FIST-V was conducted at Fort Sill, OK, Sep - Dec 1982 in conjunction with the FIST-V OT II. This report of this evaluation identified problems in the area of man-machine interface, safety and training that significantly detract from the combat effectiveness of the FIST-V. It is concluded that constraints imposed by the requirement to use the current TOW/M113APC vehicle as the basic vehicle preclude the correction of many of those problems. However, the report points out other deficiencies that are not difficult to correct or improve.

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FOREWORD

This report presents the results of research regarding human factors (man/machine interface) aspects of the Army's new Fire Support Team Vehicle (FIST-V) System. The research was conducted in conjunction with the FIST-V Operational Test II (OT II) conducted at Fort Sill, OK. during the period of September 1982 - December 1982. The Army Research Institute's Fort Hood Field Unit performed the effort in support of the US Army Operational Test and Evaluation Agency (USAOTEA). ARI developed the research design, data collection and analysis plans, and test materials in coordination with OTEA. The purpose of the research was to identify problems in the human engineering design of initial production FIST Vehicles. The findings provided information that was used by the Army as the basis for 16 engineering design changes in the FIST-V prior to further production.

This project is responsive to requirements of Army Project 2Q63739A793 and to special requirements of the US Army Operational Test and Evaluation Agency.

NOTE: The findings presented in this Research Note were approved by USAOTEA and formally published in the USAOTEA report FTR OT 647, Fire Support Team Vehicle (FIST-V) Operational Test II, November 1983.

EXECUTIVE SUMMARY

Requirement

The FIST-V Operational Test II (OT II) was conducted at Fort Sill, Oklahoma, during the period of September 1982 to December 1982. The Army Research Institute (ARI) was tasked to support the test effort and to collect, analyze and report on data relating to human factors, training and safety. ARI was tasked to collect data relating to 65 reduced data requirements (RDR's) in six areas: Mission Performance; Vulnerability/Survivability; Mobility; RAM and Logistic Supportability; Interoperability; Human Factors, Training and Safety.

Procedure

A series of questions were developed for each of the 65 RDR's. These questions were then assembled into 30 different types of questionnaire packets, (one type packet for each of 30 different FIST-V related positions). The number of packets per position varied from one to 18.

At the end of an initial collective training period FIST-V personnel, Forward Observers and FIST-V maintenance personnel were given the questions that dealt with training.

The actual FIST-V test consisted of a series of battle simulations in which the Fire Support Teams were required to carry out all of the proposed fire direction center and forward observer functions for which the FIST-V was designed. Both FIST-V and maneuver forces ("aggressor" forces) were given questionnaires relating to the system. Interviews were given after the questionnaires were completed as a follow-up in problem areas identified in the questionnaires and by on-site human factors specialists who acted as observers. Both individual and group interviews were conducted.

This combined questionnaire/interview/observation data base was then analyzed and conclusions developed.

Findings

Numerous problems which detracted from fire support team effectiveness were identified.

The operator stations and interior layout of the FIST-V are marginal at best and degrade the potential combat effectiveness of the FIST. The interior layout and crew stations have been designed with insufficient consideration of the crew members who must use them. Considerable human engineering of vehicle features is needed before the vehicle can be considered adequate.

Many of the defects which exist appear to result from an attempt to merge the two functions of FIST-HQ and target detection and lasing into a single small vehicle while maintaining equipment layout features from an earlier use of the basic vehicle (M113APC/M901 TOW vehicle). It is doubtful that either a well human-engineered FIST headquarters vehicle or fire control vehicle can be created within these two constraints. However, there are numerous man-machine interface improvements which can be made without changing the basic operational design philosophy and which will improve combat effectiveness over that of the current FIST-V version.

The potential combat effectiveness of the FIST-V concept has been degraded by man-machine interface deficiencies of the current FIST-V. A proper human factors front-end analysis with corrective action is required prior to full scale production.

Utilization

The findings presented in this Research Note were accepted and approved by the U.S. Army Operational Test and Evaluation Agency (USAOTEA) and formally published in the USAOTEA report, FTR OT 647, Fire Support Team Vehicle (FIST-V) Operational Test II, November 1983.

As a result 17 engineering design changes were made in the FIST-V prior to full scale production. This research was also used as the basis for development of a number of design criteria for use in the development of future systems similar to the FIST-V.

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I. INTRODUCTION

The FIST-V Operational Test II (OT II) was conducted at Fort Sill, Oklahoma during the period of September 1982 to December 1982. The Army Research Institute (ARI) supported the test effort and collected data to satisfy those test areas which dealt with human factors, training, and safety. Additional data collection and analysis efforts were conducted for other areas when the solicitation of opinion data from test personnel was required.

II. PURPOSE

The purposes of the ARI effort were:

1. To assist in optimizing the combat effectiveness of the FIST-V by identifying man-machine interface and training problems that escaped notice in the R&D process.

2. To recommend, as applicable, corrective systems modifications in the following areas:

- o Operator Selection
- o Training
- o Tactics or Doctrine of Employment
- o Organizational Structure
- o Equipment Design

3. To determine how well the FIST-V, as designed and manned, fit into the operational role which had been defined for it.

4. To develop design criteria for future similar systems.

III. METHOD

In a series of conferences with OTEA personnel, ARI was tasked to obtain data in each of the six major areas for which Reduced Data Requirements (RDRs) were defined. In all, a total of 65 RDRs, distributed as follows, were assigned to ARI.

1.	Mission Performance:	9
2.	Vulnerability/Survivability:	8
3.	Mobility:	11
4.	RAM and Logistic Supportability:	7
5.	Interoperability:	6
6.	Human Factors, Training, Safety, etc.:	24
	TOTAL:	65

The researchers then compiled a series of questionnaire segments, each dealing with a specific RDR. The type and number of questions varied considerably, depending upon the nature of the RDR to which the questions related. The number of questions per item varied from one to as many as 50. The longer sets of questions dealt with specifics of operator station layouts where more detail was required.

The complete set of questions was then submitted for review and approval to appropriate OTEA Headquarters personnel and, through the on-site Test Director, to on-site personnel. After the questions were approved, the onsite Test Director prepared a list which identified 30 test personnel and test controller positions to which RDR items needed to be addressed. The Test Director then prepared a matrix which specified for each position the RDR's to which the persons in those positions should be asked to respond.

The matrix was then used as the basis for assembling questionnaire packets customized for each of the positions. Thus, there were 30 different questionnaire packets. The number of packets varied from 1 to 18 depending upon the number of persons holding the position in the test process. Table I shows the surveyed positions and the number of persons in those positions. In all, a total of 149 persons were solicited for responses concerning RDR items which fell into their areas of knowledge.

TABLE I

Positions Surveyed and the Number of Persons Holding Each Position

(3) BN TF Commander	(1) CHIEF CONTROLLER
(3) BN TF S-3	(8) FIST V CONT M/I
(3) BN TF S-2	(4) FIST V CONT TK
(1) FIRE SUPPORT OFFICER	(18) FO CONT/COLL
(1) FIRE DIRECTION OFFICER	(1) TACFIRE CONT/COLL
(6) CO COMMANDER, M/I	(11) TC OPFORS
(3) CO COMMANDER, TK	(2) EW PERSONNEL
(9) PLT LDR TK	(1) EW CONTROLLER
(18) PLT LDR M/1	(10) MAINTAINER
(1) FIST CHIEF TK	(5) COLLECTOR, RAM
(2) FIST CHIEF, M/I	(7) BCS CONT/OPERATOR
(1) FIST SGT TK	(4) PILOT, COBRA
(2) FIST SGT M/I	(1) LASER SAFETY OFFICER
(6) FORWARD OBSERVER	(10) TRAINER
(6) FIST OPERATOR	(1) MAINTENANCE SUPERVISOR

At the end of the collective training period the FIST-V personnel, Forward Observers, and FIST maintenance personnel were given the questions that dealt with training.

Maneuver force personnel were changed after each battle simulation and returned to Fort Carson, Colorado. Therefore, these persons were given their questionnaires after each of the battle simulations. Because time did not permit their returning after their responses were collated, they were encouraged to comment about relevant FIST-V items as they finished their questionnaires.

After the final battle simulation portion, the OT II personnel who had questionnaires to complete were gathered into three groups. These groups were of approximately 40 soldiers each, with each group consisting of soldiers whose questionnaires were of approximately the same length.

After the questionnaire data were tabulated, reduced, and analyzed, group interviews (to discuss problems uncovered by the questionnaire results) were conducted with selected groups. These interviews were conducted with FIST-V teams (in their vehicles) and with controllers and maintainers. The interviews views were conducted during a period two to three weeks after the questionnaires were administered. The delay was the result of both the time required to reduce and analyze the data and the requirement that the interviews not conflict with the Thanksgiving leaves taken by most of the players and controllers when the battle simulation portion of the test was completed. In addition to group interviews, individual interviews were held with some of the players mentioned above and some of the other persons mentioned on the list in Table I. Notes taken during these interviews were used to supplement and clarify the earlier questionnaire data.

The material thus gathered was then analyzed by ARI personnel working in conjunction with FIST-V, OT II players and controllers. As a result of this joint effort, ARI developed the results and conclusions presented in this report.

IV. SUMMARY OF RESULTS BY MAJOR AREA

The six major areas in which ARI had data collection responsibilities were noted in the Methods section. The summary of results follows the same classification system, with further subdivision if merited.

1. Mission Performance. Fire planning was seen as being made more difficult by poor vehicle interior layout. Fire planning was considered slow, but no particular reason was advanced except that it was often noted that maneuver commanders were not always cooperative or supportive. Planning got better and more timely as FIST-V personnel became more experienced.

Self-location using PLRS could not be played. FIST-V personnel considered their use of the back-up method adequate but controllers indicated teams were much too slow. Finding targets from inside the FIST-V was considered adequate but vehicle features--windows and narrow field optics--made it more difficult than being outside with binoculars.

Conducting fire missions was a problem but a noticeable improvement occurred as FIST-V personnel became more experienced. EW created severe problems and was often either not recognized or not reacted to properly. Added to normal equipment problems the EW problem created considerable doubts about equipment performance.

Despite the problems, fire control was perceived--by players--as adequate. Communication with FO's was also seen as adequate. However, attempts to use Tank Platoon Leaders as FO's was seen as totally unsatisfactory since Platoon Leaders did not know how to call for fire and had to be talked through missions like inexperienced troops.

FIST-V personnel felt competent in passing on enemy force intelligence but seemed to feel there was no need to pass on friendly force intelligence.

2. Vulnerability/Survivability. Terrain at Fort Sill consists primarily of grassy rolling hills with limited trees and many low areas. Concealment was therefore difficult and even with camouflage nets the vehicle was easy to locate. When the FIST-V is behind cover the raised head is easy to locate against a skyline. After an opposing force determined that it was being lased, locating the FIST-V was considered by them to be easy. This occurred despite the fact that the FIST-V was often placed in less desirable overlook positions because better ones lacked cover.

EW significantly degenerated mission performance and EW personnel stated that locating the position of transmitters and, hence, the FIST-V on the battlefield was easy.

Local security, moving and stationary, was not considered a problem (seen as not really required) but a ground guide was used to move into overlook positions. Controllers reported that light leakage from inside the FIST-V was a problem and noted that that was how they located the vehicles when approaching in the dark.

Most operators were able to perform vital crew functions while in NBC (MOPP IV) conditions, although most functions took longer. Crew fatigue after several hours was noted. Controllers noted during interviews that the crew work loads during MOPP test conditions were relatively light and that the crew's concept that they could perform for longer periods would not be valid under more realistic combat workloads.

3. Mobility. Preparing the FIST-V to move was not considered much of a problem. The biggest problem was associated with the vehicle's poor stowage situation. Getting ready to move was easy. Finding where something had been stowed was often difficult.

When the GLLD was off and required remounting, the preparation took longer. If a "hasty departure" were needed to avoid enemy action, FIST Chiefs felt they would just run with the GLLD carried inside until they could stop and remount it. Dismounting the GLLD was actually seen as more of a problem than was remounting it. Boresighting requirements were not seen as a problem affecting vehicle readiness.

During the test, where road marches seldom exceeded 15 mph, the FIST-V had no trouble keeping up and could have moved at considerably faster rates. However, the vehicle is seen as top-heavy and crews experienced considerable caution when traveling cross-country or on hills. The GLLD appeared to malfunction when fast travel in rough terrain was attempted so the GLLD, not the vehicle, became the major speed deterrent. Movement "head-up" was not played but on two occasions when it was accidentally done it was an outside observer who noticed and reported it. Hence, drivers felt that head-up did not create "noticeable" driving problems but felt overhead obstructions would create serious safety problems.

Swimming the vehicle was not seen as a problem. It has a pronounced list and turns slowly. However, it is low in the water and has flat sides so it does not react too easily to water motion.

When asked what duties could be performed in the FIST-V while it was moving, crew members felt that tasks that require only voice communication can be done adequately while moving fast or slow, that use of the DMD becomes very difficult on rough terrain, and that writing, recording tasks and target seeking tasks also suffered. Lasing was not considered to be feasible while moving, although several of the operators felt they could do it if the vehicle was moving smoothly enough.

When asked about FIST-V fire support to maneuver forces, Maneuver Force Commanders and Platoon Leaders commented that the FIST-V had problems determining good overwatch positions and arriving there at the proper time during the battle.

4. RAM and Logistic Support. Availability of tools, manuals and repair parts were not seen as a problem. BITE (Built-In Test Equipment) was not as well thought of, however. Lack of experience and lack of a codebook to define the meaning of BITE responses caused maintenance problems due to marginal BITE performance.

Numerous comments cast an unfavorable light on the maintenance support concept as implemented. FIST-V personnel felt that maneuver commanders were often too slow in passing maintenance requests through proper channels. Also they felt that when maintenance people arrived, particularly at night, they were not prepared to do an acceptable job. Generally, support was seen as borderline or poor. However, the artillery actually supported the test, and the maneuver units acted only as a clearing house for logistic support. Therefore, the inadequacy of the maneuver force in supplying logistical support to the FIST-V during the test may not be a real problem. It may, in fact, be more related to the casual attitude of maneuver forces (which is discussed elsewhere in this report) and to the fact that maintenance assets were shared rather than dedicated.

About 40% of the respondents felt that there were difficulties in making repairs to the FIST-V or the equipment mounted on it. No universal causes were listed; each respondent seemed to point to a different problem.

Despite these problems, Maneuver Force Commanders and Platoon Leaders felt that the FIST-V and related FO teams were adequate in providing fire support for the maneuver force. They noted, however, that FIST-V had problems in determining good overwatch positions and arriving there at the proper time during the battle.

5. Interoperability. Most of the communication problems between the FIST and the TACFIRE can be attributed to EW measures, lack of experience of the FISTs, hesitation to go "voice" to talk over the problem, and an "it's the other guy's fault" mentality. These problems, singly and in concert, sometimes resulted in the FISTs not using TACFIRE. The TACFIRE crew, which was very experienced, indicated that the origin of most digital communication problems was at the FIST or the BCS. On the other hand, some FIST personnel claimed that the fault lay with the TACFIRE people "who were never able to admit they had a problem and blamed all the problems on FIST."

Responses of EW personnel tend to support the TACFIRE operator's position. Generally, EW stopped DMD's cold; even if the FIST DMD got a digital message to TACFIRE, it rarely got an acknowledgement.

As FIST DMD operators became more experienced, they learned how to work through some of the problems, but EW personnel felt FIST people never did develop a thoroughly competent reaction to EW.

The FIST DMD generally worked well with TACFIRE, although it seems there was an occasional problem getting acknowledgements from TACFIRE when the net was very busy. FISTs occasionally contacted TACFIRE by voice to untangle problems such as jamming or net overcrowding but generally FISTs changed frequencies only when directed by TACFIRE personnel as a way to counter EW measures.

BCS results were much the same. There were some problems, particularly in the autonomous mode, but usually the problem was EW. When problems were recognized, FIST DMD operators usually reacted by going voice, but generally EW was very effective and not well responded to by DMD operators.

Firing COPPERHEAD rounds presented some problems to the FIST. After some practice firing dry missions, procedures seemed mostly adequate. COPPERHEAD missions were generally processed at the TACFIRE and BCS very slowly because of operator inexperience, format errors as input by the FIST, and firing battery locations not being able to support firing when target angles between the battery and observer were greater than 800 mils.

The procedures for establishing a COPPERHEAD "footprint" did not work in either BCS or TACFIRE using the version 3 (test) computer program. Therefore, all missions were handled on a target of opportunity basis. BCS and TACFIRE sent different formats for COPPERHEAD messages to observers (MTO). FISTs preferred the MTO received from BCS.

FISTs encountered only minor problems in using HELLFIRE fired from helicopters. All aspects of the attack sequence were adequate. Several personnel suggsted that V/GLLD codes should be included in the CEOI. Coordination with aviation assets and initial contact with pilots were problems. HELLFIRE response time from initial request was slow.

6. Human Factors, Safety, Etc. The portion of the test which dealt most narrowly with the FIST-V itself and its direct operation and maintenance encompassed six areas: Human Factors, Safety, Personnel Selection and Training, Doctrine, Tactics and Organization. They will be addressed in the same order.

a. Human Factors. Two RDRs addressed items relating to the adequacy of the work stations. A third involved determining how well the FIST-V provided for the transport of authorized TOE equipment. It appears from the data collected relevant to these items that, at best, the work stations are unsatisfactory and only marginally designed for effective operator performance. The various stations, and other vehicle features need considerable improvement.

(1) Observation Station Layout. No real observation seating exists. The makeshift station is a significant safety hazard because the observer can easily get his foot or leg jammed in the rotating targeting station turret or under the turret. The station has no adequate seat and there are no provisions for work or writing surfaces at the station.

In interviews FIST personnel noted that the periscope was poorly located. If it were at the left rear, it would be more usable and convenient to the mapboard. It was also noted that the periscope was of minimal value. The targeting head and erector arm assembly blocked a large angle of the forward view. Also, when the FIST-V is in a safe overlook position, it is hidden except for the targeting head in the erect position. In these cases the periscope cannot see anything. The periscope, to be of any real value, should rise above the erected targeting head; and certainly it needs to be higher than the lowered targeting head.

Access to the station is blocked by the turret and the station is, therefore, hard to get to from the rear of the vehicle. Station utilization is limited because FIST Chiefs indicated they want to be by the mapboard and communication station during operations. The problems of difficult access from the rear of the vehicle, the safety problem, the lack of forward vision due to targeting head interference, and lack of battle area vision when FIST-V is placed in cover make the station of minimal use and detract from combat effectiveness.

It was generally agreed during the interviews that the observation station should be at the left rear of the turret and that it should have a periscope that could rise above the erect targeting head.

(2) Communications Station Layout. Although there were a number of problems with this station, it is the most adequate of the three stations. However, the seat is too low and the position cramped. During interviews it was pointed out that reversing the location of the Intercom Control Unit and the Intercom Distribution Unit would put the most used controls within reach. It was also noted that putting the mapboard to the right of the position--and making is smaller--would be desirable. Lighting was also considered a problem during interviews. It was considered likely that painting the entire interior of the vehicle a matte white would improve the lighting.

Noise level at the station was a significant problem for most soldiers. Most also found that ventilation was either marginal or unsatisfactory.

No sound argument was made during interviews for additional radios, but the point was made that voice on the same frequency as digital created significant digital problems. Also, any need for the FIST Chief to leave the FIST-V to be with the maneuver commander was discounted because departure of the Chief would leave the FIST-V short a radio.

(3) Targeting Station Layout. The station seat was considered inadequate. During interviews the need for a seat back was stressed. Crew members indicated the absence of a seat back went beyond mere fatigue and discomfort. Extended duty at the station, especially on grades, created the potential for more serious back problems. The work station is very tight. It was also noted during interviews that small items were constantly being lost under the turret. A screen to prevent this is considered essential.

Although the general layout of the panels was considered minimally adequate there were significant defects noted during interviews,,including:

(a) Intercom Control Unit on front right wall was nearly unreachable.

(b) GLLD, Designate-Range Switch has so little movement you can't tell what position it is in and there is no feedback. The switch should have a longer throw or a light to designate position.

(c) Switches at operator's lower right are not adequately lighted. A flashlight was needed to see them at night.

(d) Structure at the ring at top of vehicle tore target station operator's gloves as he used laser. If it tears gloves, it will tear fingers and MOPP gear.

(e) The circuit breakers on the base of the turret are exposed and on many occasions were kicked or bumped and thrown to the off position.

(f) V/GLLD operations with the head removed were hindered because of problems in replacing the head. Replacing the targeting head was made difficult because the "J" shaped, spring-loaded, lock mechanism was prone to bind in the thin structure. Holding it in position while handling the V/GLLD make the replacement more difficult.

(g) On the average, temperature control and ventilation at the station were found unsatisfactory.

(4) Other Vehicle Features. FIST-V stowage is grossly inadequate. During inteviews, numerous suggestions were made including:

- Put tank type racks on sides for exterior storage of items.
- Put rifle racks on ramp.
- Provide drawers or boxes for pencils, small items, etc., and acetate.
- Put a weather tight storage box on top outside of ramp so it will be level when open on flat ground.
- Put rail over battery case area to help hold items stored there.

In general, the stowage problem that existed during the exercise was seen as almost unmanageable. The best suggestion, unanimously seconded, was to put the FIST-V in a bay with all the equipment it carried and all crew member equipment. Then develop a loading plan and add racks, etc. to make storage secure and easily accessed. It was also noted that much of the FIST-V equipment stored in boxes in the vehicle was never used. One of the suggestions during interviews was to eliminate some of the equipment presently carried if a real need for it could not be articulated. Putting things back into storage was pointed to as the biggest problem in preparing to move. Finding them again in the new position was often time-consuming.

b. Safety. The current FIST-V design results in unnecessary risk to operators of serious injury or death. The major safety problem was the proximity of the observation station to the rotating turret. Operators felt that it would be easy, particularly when fatigued, to get their foot or leg caught in the turret mechanism. They also felt it was possible to get a foot under the turret. It was also noted that the ramp was slippery when wet, that working on the top of the vehicle was dangerous when someone was in the Targeting Station (switches that controlled head up/down movement were easy to bump and throw) and that the exposed circuit breakers on the turret base could cause a dangerous situation by turning off power in critical battle situations.

The lack of a seat back in the Targeting Station was also seen as a safety problem since it could cause back strain. It was also noted that there were many protrusions, some with sharp edges, and it was easy to get one's head bumped operating in such a confined space.

c. Personnel Selection and Training. As a group the FIST-V players were above average in ASVAB scores. They appeared to be a representative sample of persons in the sampled MOS's. No peculiar abnormalities were noted in the educational or backgound of the respondents. Data from the 12 persons who were assigned to the three FIST-V teams also indicated that the teams were composed of persons representative of the pool of persons available to staff FIST-V teams in the Army.

Performance on the selected, critical SQT tasks was generally poor. However, later performance in the training portions of the test process appears to indicate that the group was not particularly inept. The most noteworthy deviation was the fact that one officer, a college graduate, read at only a sixth grade level and performed very poorly in map reading. All personnel successfully completed their training courses. However, operators felt somewhat insecure and undertrained when they left the individual training courses, and when they completed collective training. It is hard to estimate how realistic was this feeling of inadequacy. FIST personnel performed well in training, did not require added or new training, and, during collective training and the OT II process, continued to improve their performance. It seems reasonable to conclude that the training was adequate and that the general lack of experience and lack of experienced associates were the cause of the anxieties.

Comments during interviews reiterated suggestions concerning the desirability of assigning persons positions before individual training ends and giving them extra practice for specific jobs. Interviewees felt that this would help compensate for the fact that there is no body of experience in the group in which the new trainee finds himself.

Maintenance people felt more secure as they finished individual training. However, there were indications that their greater feelings of confidence were less merited than the operator's feeling. Maintenance respondents were not very communicative during interviews, but it does seem possible that either the maintenance training was not as effective as operator training or the need for experience and experienced associates is greater.

When the test exercise began, about one-quarter of the respondents felt that some persons on the test team, including controllers, were performing marginally. Generally, respondents felt additional training would not correct the problem. Questionnaire responses and interview comments indicated that attitude and overall experience were mostly seen as the problem--not training. The comments about performance seemed to indicate that operators performed better than maintenance personnel. Here again, however, it is unclear whether this was a real defect or an artifact of the test situation that gave operators a much better opportunity to gain relevant experience.

When asked about the nature of training problems, respondents pointed to training under adverse conditions--night, CBN, and rain/poor weather--and said it was too limited. Beyond that the respondents provided little specific information. About one-third felt that there were factors other than course content that affected training. During interviews, attitude of trainees was the most specific complaint.

Comments by respondents indicated a lack of self-confidence in their abilities after individual training. This is attributed to their lack of previous experience with the equipment rather than a deficiency in training. In reality, they performed well. No added or new individual training was required. They were well prepared for the collective training phase and for the OT itself. Their performance, however, continued to improve during the course of both collective training and the OT.

Manuals were considered adequate. During interview the "adequate" judgment was often tempered with the statement "compared to other Army manuals". Some respondents felt there was a need for training or simulation devices but there was not much agreement on what was desirable. When asked if there were any special attributes needed to be FIST-V team members, training and experience were given rather than personal characteristics. But during group interviews, there was considerable joking that the FIST-V was designed for little people.

d. Doctrine. RDRs in the Doctrine area for which ARI collected data dealt with the ability of the FIST-HQ to operate when "split" and on the adequacy of the FIST-V for HQ operations. The test process did not play situations which required the FIST Chief to operate with the maneuver commander. Answers to

this item were therefore conjecture. Respondents indicated that even given an extra man to fill out the FIST-V crew they would expect some problems. In interviews, FIST Chiefs indicated they would have communication problems, since they would have one of the FIST-V radios. FIST Chiefs felt that if they were with the maneuver commanders, planning and/or updating fire plans would suffer but their other tasks would not be much affected except for communciations problems that might occur with the FIST-V short one radio.

The Workspace was considered inadequate. Lighting was marginal for maintaining maps, etc., and doing fire planning. The mapboard is poorly located and stowage for maps, acetate, etc., is lacking. It should also be recalled that FIST Chiefs indicated that the commander's periscope is of little value (not high enough to view battle areas and not located in the FIST-V where they can use it).

e. Tactics. Since Fort Sill terrain is not well-suited to concealment positioning, co-locating the FIST-V was often a problem. Maneuver commanders noted that the FIST-V had problems getting to overlook positions in time and that better positions often could not be occupied because of cover problems.

FIST Chiefs felt that the vehicle could usually be placed where the targeting head has a suitable visual field but the observation station periscope usually has its view obstructed because it is lower than the raised head. Also, the targeting arm and head obstructs the view. Windows, of course, provide only a limited view. The result is a difficult-to-work-in vehicle with limited observation of the battle area capabilities.

Night and/or MOPP operations did not increase the difficulty any great amount, but there were night and MOPP operator problems due to lack of experience. Test controls were also seen as reducing the flexibilitiy that FIST Chiefs would usually need in positioning the FO's and in dealing with FO's so the full scope of the positioning problem cannot be judged.

f. Organization. The four-man crew is not considered large enough for extended continuous operations. FIST Chiefs felt that the loss of a single man would seriously curtail operations. The interior layout of the FIST-V is considered to be marginal for conducting HQ operations and, when taken in conjunction with target detection and lasing duties, made HQ operations tenuous.

V. CONCLUSIONS

1. The operator stations and interior layout of the FIST-V are marginal at best and degrade the potential combat effectiveness of the FIST. The interior layout and crew stations have been designed with insufficient consideration of the crew members who must use them. Considerable human engineering of vehicle features is needed before the vehicle can be considered adequate.

2. Many of the defects which exist appear to result from an attempt to merge the two functions of FIST-HQ and target detection and lasing into a single small vehicle while maintaining equipment layout features from an earlier use of the basic vehicle (M113APC/M901 TOW vehicle). It is doubtful that either a well human-engineered FIST headquarters vehicle or fire control vehicle can be created within these two constraints. However, there are numerous man-machine interface improvements which can be made without changing the basic operational design philosophy and which will improve combat effectiveness over that of the current FIST-V version.

3. The potential combat effectiveness of the FIST-V concept has been degraded by man-machine interface deficiencies of the current FIST-V. A proper human factors front-end analysis with corrective action is required prior to full scale production.